(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 024 636**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 80104787.9

(22) Date of filing: 13.08.80

(51) Int. Cl.³: A 47 L 9/00

(30) Priority: 16.08.79 JP 103609/79
12.03.80 JP 31924/80

(43) Date of publication of application:
11.03.81 Bulletin 81/10

(84) Designated Contracting States:
DE FR GB SE

(71) Applicant: Hitachi, Ltd.
5-1, Marunouchi 1-chome
Chiyoda-ku Tokyo 100(JP)

(72) Inventor: Sagawa, Kohichi
3-7-3-2, Kokubu-cho
Hitachi-shi Ibaraki(JP)

(72) Inventor: Matsumoto, Yoshihiro
4-33-12, Nishinarusawa-cho
Hitachi-shi Ibaraki(JP)

(74) Representative: Beetz, sen., Richard, Dipl.-Ing.
Patentanwälte Dipl.-Ing. R. Beetz sen. Dipl.-Ing. K. Lamprecht, Dr. Ing. R. Beetz jr. et al,
Rechtsanwalt Dipl.-Phys. Dr. jur. U. Heidrich Dr.-Ing. W. Timpe, Dipl.-Ing. J. Siegfried Priv.-Doz. Dipl.-Chem. Dr.rer.nat. W. Schmitt-Fumian
Steinsdorfstrasse 10 D-8000 München 22(DE)

(54) **Vacuum cleaner.**

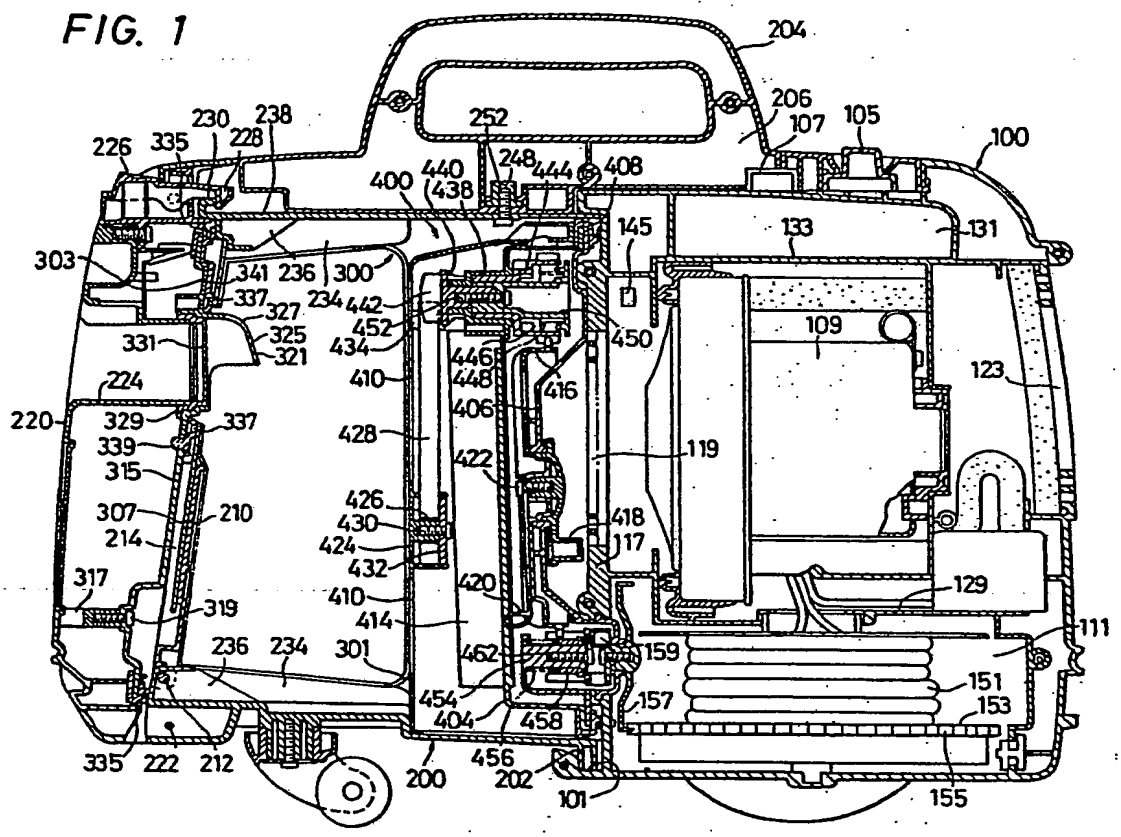
(57) A vacuum cleaner comprising a body case (100) having a motor-driven fan (109), a dust case (200) detachably connected to the body case (100) and a bag-shaped fine filter (301) made of paper.

In order to prevent the bag-shaped fine filter (301) made of paper from being broken when dust is shaken off the inner surface of the fine filter (301) to improve the dust collecting performance of the fine filter (301), a filter sustainer (410) is arranged in the dust case (200) for sustaining the fine filter (301) in contact with the outer surface thereof and a vibrating device (428) is arranged in the dust case (200) for causing the filter sustainer (410) seesaw movement so as to give shaking motion to the fine filter (301).

EP 0 024 636 A1

./...

FIG. 1


204
206
107
105
100
252
248
444
408
230
238
228
226
335
400
440
438
145
133
131
303
341
236
300
337
327
234
442
452
434
325
321
331
450
109
123
224
410
446
448
416
406
220
329
337
339
315
428
422
119
426
430
424
432
410
414
307
210
214
317
319
418
117
420
129
111
236
234
301
462
159
151
153
454
404
458
157
335
222
212
200
456
202
101
155

0024636

TITLE OF THE INVENTION

Vacuum Cleaner

BACKGROUND OF THE INVENTION

This invention relates to an improvement in a vacuum cleaner equipped with a dust collecting bag, made of such material as paper, which is to be disposed of together with dust contained in it.

This kind of vacuum cleaner has the advantage of easy disposal of dust while it also has the disadvantage of having a very low dust collecting ratio; i.e., the ratio of the actual volume of dust collected to the effective volume of bag is about 1/2 to 1/3. This is because the meshes of the dust collecting bag become clogged with dust loosing its porosity before the bag is filled with dust.

To improve the dust collecting ratio we have tried various methods of shaking the dust off the bag. The biggest problem we have encountered is that the dust collecting bag made of paper is weak in strength and is liable to break.

For example, if the bag is rubbed on its outer surface with a dust remover made of wire, it will be torn because the outer surface of the bag is uneven and complex in shape.

SUMMARY OF THE INVENTION

The object of this invention is to provide a vacuum cleaner having easy disposal of dust and high dust collecting ratio.

To achieve this object, the vacuum cleaner of this invention comprises: a body case having a motor-driven fan; a dust case detachably connected to the body case; a first fine filter member detachably arranged in the dust case; and a filter sustaining member arranged in the dust case for sustaining the fine filter member in contact with the outer surface thereof.

According to one embodiment of this invention, the porosity or the suction performance of the bag-shaped fine filter can easily be recovered by vibrating the filter sustaining member because when the filter sustaining member is vibrated, the bag-shaped fine filter is also vibrated thereby shaking the dust off the fine meshes of the filter.

Moreover, since it is through the filter sustaining member that the vibration is applied to the bag-shaped fine filter, the bag-shaped fine filter is free from any breakage which would occur if it were rubbed on its outer surface with the dust removing member.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a vertical cross section of the vacuum cleaner of this invention;

Figure 2 is a perspective yiew of the vacuum cleaner disassembled:

Figure 3 is a perspective view of the body case disassembled:

Figure 4 is a perspective view of the dust case disassembled:

Figure 5 is a perspective view of the dust case cover disassembled:

Figure 6 is a perspective view of the filter unit disassembled:

Figure 7 is a schematic view showing the first fine filter member being taken out of the dust case;

Figure 8 is a schematic view showing the filter unit being taken out and the dust being thrown off;

Figure 9 is a detailed view showing the first fine filter member being assembled into the dust case;

Figure 10 is a detailed view showing the first fine filter member being taken out of the dust case;

Figure 11 is an enlarged view of the coarse filter as viewed from the back;

Figure 12 is an enlarged view of the projection and the vibration

transmitting member, showing how the coarse filter and the first fine filter member are removed of dust;

Figure 13 is a schematic view showing the dust-laden air stream flowing into the first fine filter member;

Figure 14 is a graph showing the dust collecting performance characteristic of the first fine filter member; and

Figure 15 is another graph showing the dust collecting performance characteristics of the first and second fine filters and the resultant dust collecting performance characteristic when these two characteristics are combined.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

We will now explain one embodiment of this invention with reference to the accompanying drawings.

This vacuum cleaner comprises a body case 100 and a dust case 200. The body case 100 and the dust case 200 are detachably connected as shown in Figure 1. This connection is accomplished, as shown in Figures 1 and 2, by first inserting the projection 202 at the lower portion of the dust case 200 into the groove 101 at the lower portion of the body case 100 and then inserting the rear portion of the base plate 206 for the handle 204 provided at the upper portion of the dust case 200 into the recess 103 formed at the upper portion of thebody case 100 to cause the claw 107 of the clamp 105 at the upper portion of the body case 100 to engage with the base plate 206.

The body case 100 incorporates a motor-driven fan 109 and a cord winding device 111.

The body case 100 is split longitudinally at the center ***

into a left-hand side portion 113 and a right-hand side portion 115, both being fitted together by screws not shown.

The left- and right-hand portions 113, 115 have an air inlet port 119 formed on the front wall 117 and an exhaust port 123 on the rear wall 121. The fan container chamber 125 at the center of the body case 100 is separated by a partition plate 129 from the cord winding device container chamber 127 located under it. On the upper side of the fan container chamber 125 is provided a spare filter storage chamber 131 for storing the spare of the first fine dust collecting filter 300. The spare filter storage chamber 131 and the fan container chamber 125 are also separated by a partition plate 133.

These partition plates 129, 133 extend parpendicular to the longitudinal, vertical dividing surface at the center of the body care and spread through the interior space of the left- and right-hand side portions 113, 115.

The spare filter storage chamber 131 is open to the outside of the body case through an opening formed on the external wall of the right-hand side portion 115. Through this opening the spare of the first fine filter 300 is placed into or taken out of the spare filter storage chamber 131. Normally, this opening is closed by a detachable cover 137 which has a recess 139 to receive fingers for its removal and an enagagement claw 141 for holding it

to the opening.

Since the spare filter storage chamber 131 gives the upper portion of the body case 100 a double-ceilinged construction, the noise produced by the electric fan 109 can be reduced. Because the body case 100 is split longitudinally at the center into halves, the complex construction of the body case including the spare filter storage chamber 131, the fan container chamber 125 and the cord winding device container chamber 127 can easily be formed through molding. If the body case 100 is to be molded as one piece, it would require a complex molding pattern and make the molding process complicated.

A dust indicator 143 is located immediately below the opening on the right-hand side body portion 115. It is connected to the negative pressure port 145 and held in position by the cover 147. The cover 147 is secured by the screw 149 threaded from the inside of the right-hand side body portion 115.

The negative pressure port 145 opens to the outside in the same direction as the opening of the spare filter storage chamber 131 so that the molded product may easily be separated from the pattern.

The cord winding device 111 has a cord reel 153 to wind the cord 151. The cord reel 153 has teeth 155 formed on the outer periphery which are in mesh with an intermediate gear 167

rotatably supported on the front wall 117 of the body case 100. This intermediate gear 157 is fitted with a driving coupling 159 which is exposed to the outside of the front wall 117 and is connected to the dust remover of the filter unit provided in the dust case 200. The filter unit will be detailed later on.

Next, we will explain the construction of the dust case 200. As shown in Figures 1, 2 and 4, the dust case 200 is hollow.

On the front side of the dust case 200 is formed an opening through which the first fine filter 300 is placed into or taken out of the case 200. Fitted to the opening is a filter support plate 210 which is rotatably supported on the shaft 212 mounted at the lower portion of the opening so that the support plate 210 can be rotated forwardly about the shaft 212.

The height of the filter support plate 210 is about half that of the opening for the first fine filter. Thus, when the filter support plate 210 is palced into position, the lower half of hte opening is covered by the plate.

The filter support plate 210 has a recess 214 formed on its front surface which leads to the upper end of the plate 210. The upper portion of the recess 214 is expanded stepwise on each side to form a receiver portion 216 or which the lower corners of a plate 303 for the first fine filter 300

rest. The opening for the first fine filter 300 also has a recess 218 formed stepwise on the upper portion thereof to receive a portion of the filter 300. The functions of these recesses will be explained later.

The dust case cover 220 is rotatably supported on the shaft 222 located at the lower portion of the dust case 200 so that it can open or close the opening for the first fine filter from the external side of the filter support plate 210. The dust case cover 220 has a clamp 226 and a connector hole 224 into which a suction hose not shown is inserted.

The clamp 226 has a claw 228 which engages with the engagement portion 230 provided to the dust case 200. The front opening of the dust case 200 for the first fine filter can be closed by the dust case cover 220 by engaging the claw 228 of the clamp 226 with the engagement portion 230. The detailed construction of the interior of the dust case cover 220 will be described later.

The rear side of the dust case 200 can be brought into and out of engagement with the front side of the body case 100. The dust case 200 has an opening on its rear side through which the filter unit 400 to be detailed later can be placed into or taken out of the dust case 200.

The dust case 200 has a plurality of ribs 234 on the inner surface to sustain the first fine filter 300. These ribs 234 extend forwardly from the interior surface of the

dust case near the rear opening to the front opening, from which the first fine filter is to be taken out.

Extending parallel to and between these ribs 234 are guide ribs 236 which are formed near the front opening of the dust case 200 to guide the first fine filter when drawn out. These guide ribs 236 are inclined upwardly toward the front opening.

The dust case 200 has a ceiling plate 238 in the upper interior, above which is formed a room 240 for receiving the base plate 206 of the handle 204. The handle 204 consists of longitudinally split portions 242, 244 fastened together by screws 246. The screw seat 248 for the handle 204 is fitted into the receiver portion 250 of the handle portions 242, 244 during the process of assemblying the handle portions 242, 244.

After being inserted into the room 240, the handle 204 is secured to the dust case 200 by a screw 252 which is threaded from inside the dust case 200 into the screw seat 248 through the ceiling plate 238. The screw seat 248 is located at the central portion of the handle 204, i.e., at the center of gravity of the vacuum cleaner so that the receiver portion 250 will not be subjected to an excess load when the vacuum cleaner is carried.

Now, we will explain the construction of the first fine filter 300. As shown in Figures 1, 2 and 3, the first fine filter 300 consists of a bag 301 made of thin, flexible, porous paper and a support plate 303 made of hard paper such

as cardboard. The bag 301 is bonded to the support plate 303 with adhesive agent.

The support plate 303 is comprised of a dust suction port 305 and a cover portion 307 for covering the port 305. The cover portion 307 can easily be bent along the perforated line 309 which is formed on the support plate 303 to facilitate the bending of the cover portion 307. The cover portion 307 has two lines 311 cut into the free end to form an engagement piece 313 which can be bent relatively easily. This support plate 303 can easily be formed by punching a sheet of plate material.

The dust suction port 305 can be closed by bending the cover portion 307 until it contacts the support plate 303. To retain the cover portion 307 in the bent position, the engagement piece 313 is slightly bent to engage with the inner edge of the dust suction port 305.

Before use, the bag 301 and the cover portion 307 of the first fine filter 300 are folded to be compact as shown in Figure 3. Since the filter 300 is small and compact, it does not require a large space for storage and can be easily be placed into or taken out of the filter storage chamber 131.

We will explain how the first fine filter 300 is assembled into the dust case 20a. The process of placing the filter 300 into position consists of opening the cover portion 307 of the filter 300, engaging the cover portion 307

with the recess 214 of the filter support plate 210, inserting the bag 301 into the dust case 200, and then engaging the upper and lower portions of the support plate 303 with the recesses 216, 218. With the dust case cover 220 closed, the vacuum cleaner is now operable.

In this way, the assemblying of the first fine filter 300 can easily be done by engaging the support plate 303 with the recesses 216, 218.

The internal construction of the dust case cover 220 will be explained in the following. As shown in Figures 1 and 5, an inner cover plate 315 is fitted to the inner side of the dust case cover 220. It is secured to the dust case cover 220 by means of screws 319 threaded into the screw seat 317.

The inner cover plate 315 is provided at its upper portion with a deflecting suction port 321 whose delivery port is directed downward. The deflecting suction port 321 has a vent 327 at the bent portion of the guide 325. The deflecting suction port 321 is connected through the seal packing 329 to the internal end of the hose connector 224. The seal packing 329 is formed integral with a back-flow preventing valve 331 made of elastic material such as rubber or flexible vinyl chloride. The back-flow preventing valve 331 moves about the connecting portion with the seal packing 329. The back-flow preventing valve 331 is provided inside

the deflecting suction port 321 so that it is automatically opened by the action of the air stream passing through the hose connector 224 and closed when there is no air stream. The functions of the deflecting suction port 321, the vent 327 and the back-flow preventing valve 331 will be detailed later.

The inner cover palte 315 has around its periphery a seal packing 333, which has an annular tongue 335 formed on its inner surface. The tongue 335, when the dust case cover 220 is closed, is pressed against the circumference of the front opening of the dust case 200 to seal the gap between the dust case 200 and the dust case cover 220.

The deflecting suction port 321 is provided around its base portion with a seal packing 337 which has a projection 339. By inserting the projection 339 into a hole 315 of the inner cover plate 315, the seal packing 337 can be secured to the inner cover plate 315. The seal packing 337 for the suction port 321 has a connecting portion 341 through which it is formed integral with the seal packing 333 for the cover. When the dust case cover 220 is closed, the seal packing 337 presses against the support plate 303 thereby sealing the gap between the inner cover plate 315 and the support plate 303. With the dust case cover 220 closed, the deflecting suction port 321 projects, through the dust suction port 305 of the support plate 303, into the bag 301.

Description on the construction of the filter unit 400

follows. As shown in Figures 1 and 6, the filter unit 400 consists mainly of a coarse filter frame 402, a second fine filter frame 404, a filter support base plate 406 and a seal packing 408.

The frame 402 has a flat coarse filter 410 on the front and auxiliary coarse filters 412 on each side and the top. These filters 410, 412 are formed of a net of nylon, polyethylene, or polypropylene and the size of the mesh is sufficiently larger than that of the first fine filter 300. That is, the first fine filter 300 is capable of catching the fine dust such as sand while these filters 410, 412 cannot arrest them.

The second fine filter frame 404 has a wave-shaped second fine filter 417 made of nonwoven fabric. The mesh of the second fine filter 414 is almost the same in size as the first fine filter 300. The second fine filter 414 is arranged downstream of the first fine filter 300 so that dusts that have passed through the first fine filter 300 may be caught by the second fine filter 414, thus preventing the fine dust from being blown out from the exhaust port 123 of the body case 100.

The filter support base plate 406 rotatably supports a dust removing gear 416 located at its front and a dust removing handle 418 at the back. A dust remover 420 of elastic material, the gear 416 and the handle 418 can be

held together and mounted to the filter support base plate 406 by fixing the dust remover 420 to the front side of the gear 416 by means of the screw 422 and by threading the screw into the handle 418.

The assemblying of the filter unit 400 consists of putting together the rear side of the second fine filter frame 404 and the front side of the filter support base plate 406, fitting the seal packing 408 around the frame 404 and the plate 406 thus holding them together, and fitting the coarse filter frame 402 to the frame and plate assembly from the side of the second fine filter 414.

When the filter unit 400 is placed into the dust case 200, the outer circumference of the seal packing 408 is brought into tight contact with the inner surface of the dust case 200.

The front end of the dust remover 420 is in contact with the back of the folded second fine filter 414, so that when the handle 418 is rotated the dust remover 420 hits or snaps the crests of the wave-shaped filter 414. This vibrates the filter 414 shaking off the dust.

The coarse filter frame 402 has a hammer-vibration type dust removing device inside it. As shown in Figures 1, 6, 11 and 12, a support boss 426 is provided to the back of the non-porous portion 424 near the center of the coarse filter 410. A hammer rod 428 formed of spring material is

secured at one end to the boss 426 by a seat plate 432 and a screw 430 threaded into the boss 426.

A projection 434 to be hit by the opposite free end of the hammer rod 428 is attached to the back of the coarse filter 410. A vibration transmitter 436 extends, like a fork, from the base of the projection 434 to the right and the left on the surface of the coarse filter 410.

When the projection 434 is struck by the hammer rod 428, the coarse filter 410 will vibrate. The vibration is conveyed through the fork-like vibration transmitter member 436 over the entire filter 410.

Since the hammer rod 428 hits the projection 434 near its free end, the coarse filter 410 is vibrated like a seesaw with the projection 434 working as a fulcrum. The vibration of the coarse filter 410 causes the first fine filter 300 in contact with it to vibrate, shaking the dust off the inner surface of the filter 300.

The second fine filter frame 404 is provided at its upper portion with a bearing 438 on which a cam member 442 is rotatably supported through a seal packing 440. Installed to the back of the bearing are an idler gear 444, a clutch ring 446, a spring 448 and a connecting cylinder 450, all these being secured together by a screw 452 that is screwed into the cam member 442.

Rotation of the cam member 442 is accomplished by

rotating the idler gear 444, but it is rotated in one direction only because of the clutch ring 446.

The cam member 442 is arranged so that it will engage with the free end of the hammer rod 428; the idler gear 444 is in mesh with the dust removing gear 416. Hence, turning the handle 418 rotates the gear 416 which in turn revolves the cam member 442, flipping the free end of the hammer rod 428. This hammer rod 428 in turn hits the projection 434.

The filter support base plate 406 has a bearing 454 which, through the spring 456, rotatably supports a driven coupling 458 which is secured to the bearing by the screw 462 threaded through the seat plate 460 into the bearing 454. The driven coupling 458 has teeth formed around its periphery which is in mesh with the dust removing gear 416. When the body case 100 is combined with the dust case 200, the driven coupling 458 is connected with the drive coupling 159. With these coupling connected, the rotating force of the cord reel 153 of the cord winding device 111 is transmitted to the dust removing device provided to the filter.

The cam member 442 is rotated in only one direction when the cord 151 is pulled from the cord reel 153 but not when wound up on the reel 153. This contributes to making small the rewinding coil spring in the cord winding device 111 which is used to rotate the cord reel 153.

So far we have explain the vacuum cleaner of this invention from the view point of construction. In the following we will describe the action of each component.

As the electric fan 109 is driven, an air stream laden with dust flows through the suction hose, the hose connecting hole 224 and the deflecting suction port 321, and into the bag 301 of the first fine filter 300. Most of the coarse and fine dust are caught by the filter 300 and the remainder of dust that passed through the mesh of the filter 300 further flows past the coarse filters 410, 412 toward the second fine filter 414 where the fine dust is arrested. The air removed of dust further flows through the meshes of the filter 414 and is exhausted from the exhaust port 123 of the body case 100.

The bag 301 of the first fine filter 300 is in folded condition when assembled into the dust case 200. But as the air flows into the bag 301, it becomes inflated by the air pressure until it contacts the filter retaining ribs 234.

Although the bag 301 is surrounded by the coarse filter 410 and the filter retaining ribs 234, the bag 301 is maintained highly porous because the coarse filter 410 has sufficient porosity and there is sufficient spacing between the ribs 234.

The dust is first caught by the bag 301 at the area facing the coarse filter 410. As this area of the bag 301 becomes clogged, most of the air passes through the other area of

the bag that faces the filter retaining ribs 234 and then flows past the coarse filters 412 at the sides and the top of the frame 402 and into the second fine filter 414. The dust collecting process of the bag 301 of the first fine filter 300 proceeds in this way.

When a large amount of dust adheres to the bag as well as the second fine filter 414 and the suction force becomes lowered, the dust can be shaken off these filters either by rotating the cord reel 153 of the cord winding device 111 or turning the handle 418 to actuate the dust remover 422 and the hammer rod 428.

Since in removing dust from the bag 301 the hammer rod 428 applies ribration to the coarse filter 410, not directly to the bag, no damage will be done to the bag. The bag 301 is made of relatively weak material such as paper, so rubbing the outer surface of the bag 301 with something like the dust remover 420 will cause damage to it. But in this device, the vibration is imparted to the bag through the coarse filter 410 so that no excess force will be applied to it.

The coarse filter 410, when the projection 434 is hit by the hammer rod, is vibrated like a seesaw with the projection 434 as a fulcrum. This seesaw movement gives shaking motion to the bag 301 so that the dust is effectively removed from the inner surface of the bag 301.

Although a great amount of dust and dirt adheres to the

portion of the bag that is in contact with the coarse filter 410, the application of vibration to this portion of the bag thoroughly removes dust from it, recovering the dust collecting capability of the cleaner.

In this way, by performing the dust removing operation, as required, the dust can effectively be caught in the first fine filter 300 until the bag is filled with dust. When the bag becomes full of dust, the first fine filter 300 is taken out of the dust case 200 to replace it with a new one.

The first fine filter 300 is replaced in the following manner. As shown in Figure 10, the dust case cover 220 is opened by operating the clamp 226 and then the dust suction hole 305 is closed by the cover 307. Then, the operator holds the support plate 303 with hand and pulls it out together with the bag 301, with the filter support plate 210 being opened by the bag. In this way the first fine filter 300 is easily drawn out of the dust case 200.

The cover portion 307 that closes the dust suction hole 305 prevents the dust contained in the bag from falling from the hole 305 when the filter 300 is taken out. After being drawn out, the dust loaded first fine filter is discarded. The guide ribs 236 facilitate the removal of the filter 300 from the case. How the new filter 300 is assembled into the case has already been mentioned and its description will not be repeated here.

As already explained, since the first fine filter 300 is placed into and taken out of the dust case 200 through the front opening of the case which is accessible by opening the dust case ocver 220, the placement and removal of the filter 300 can be carreid out independently of the filter unit 400. This ensures an easy handling of the filter.

The amount of dust caught by the second fine filter 414 in the filter unit 400 is very small (more than about 95% of the dust sucked into the hose is arrested by the first fine filter 300) and therefore the number of times the dust caught by the second fine filter 414 is required to be discarded is quite few compared with the first fine filter 300 . In spite of this fact, the second fine filter 414 should be removed of dust as often as is required for the first fine filter 300 , for the following reasons. That is, if the dust remains adhering to the second fine filter 414 when the first fine filter 300 is replaced with a new one, the dust suction capability of the vacuum cleaner will not be recovered to sufficiently high level. Hence, to recover the dust sucking capability it is necessary to remove dust from the second fine filter 414 at the same time that the first fine filter 300 is replaced.

When the amount of dust caught by the second fine filter 414 exceeds a certain limit, shaking the dust off the filter 414 will prove ineffective in recovering the

sucking force because when the vacuum cleaner is operated the dust collected will soon be blown up by air to clog the filter 414. In this case, the dust must be disposed of by removing the filter unit 400 from the dust case 200, as shown in Figure 8.

In disposing of dust collected by the second fine filter 414 and maintaining the filter unit 400, the filter unit 400 is taken out through the rear opening of the dust case 200 so that the filter unit 400 can be handled independently of the first fine filter 300.

What effect the operation for removing dust from the first and second fine filters has on the suction force of the vacuum cleaner will now be explained in detail referring to the diagrams shown in Figures 14, 15.

Figures 14, 15 show the relation between the amount of dust caught by the filters 300, 414 and the suction force.

The dotted line (a) in Figure 14 (for the first fine filter 300) shows the dust collecting performance characteristic when no dust removing operation was performed for the filter 300. In this case, as the dust caught by the filter 300 increases in the amount, the filter becomes clogged resulting in an abrupt reduction in the suction force, which is indicated by the indicator 143 showing the suction level has reached the saturation. Let V stand for the amount of dust collected until the saturation is

In other words, the loss of suction force a with the second fine filter 414 remains unrecovered. If the second fine filter 414 is removed of dust, the lost suction force will be recovered, restoring the full suction force to the cleaner.

Thus, in a vacuum cleaner having the first fine filter 300 and the second fine filter 414 arranged downstream of the first one, it is necessary to remove dust from the second filter 414 when replacing the first filter 300, so as to recover the lost suction force completely.

The dust-laden air flowing into the bag 301 is deflected downward by the deflecting suction port 321 to be slowed down so that the force with which the air strikes against the inner surface of the bag is mitigated. This protects the bag against possible breakage.

Moreover, the back-flow prevention valve 331 formed of elastic material provided inside the deflecting suction port 321 will contribute to reducing the speed of the air stream. To describe more specifically, the back-flow prevention valve 331 is opened by the air stream until it is blocked by the deflecting suction port 321. The opening angle of the back-flow prevention valve 331 is about 45° so that the dust-laden air impinging on the valve 331 is deflected downward. The elasticity of the back-flow prevention valve 331 permits the valve, when struck with air, to be deflected thus greatly reducing

reached.

The zigzag line (b) shows another dust collecting performance characteristic when the dust removing operation for the filter 300 was carried out appropriately. In this case, the suction force recovers to a certain degree each time the first fine filter 300 is cleared of dust, so that the level of the suction force does not fall rapidly as the amount of dust collected increases, as with the preceding case. With the dust removing operation performed, the amount of dust collected until the suction level reached the saturation is 2.5 to 3 times greater than when no dust removing operation was done.

Referring to Figure 15, the dust collecting performance characteristic (c) for the vacuum cleaner as a whole is the sum of the dust collecting characteristic (d) for the first fine filter 300 and that (e) for the second fine filter 414. For the sake of simplicity, consider the case in which no dust removing operation is performed to either filters 300, 414 until the saturation is reached for the suction level.

When the first fine filter 300 is replaced with the new one upon saturation, the suction force b that has been lost is recovered completely. HOwever, because the total suction force that has been lost is c, the vacuum cleaner as a whole does not recover the full suction force.

the air speed.

The reason that the vent 327 is provided to the bent portion of the guide 325 which comprises the deflecting suction port 321 is to prevent the flapping of the back-flow prevention valve 331. When the back-flow prevention valve 331 is deflected by the air stream striking against it, the air contained in the space defined by the valve 331 and the guide 325 is exhausted through the vent 327. But if the deflecting suction port 321 is not provided with the vent 327, the air in that space is compressed and the pressure of the compressed air exerts reactive force upon the back-flow prevention valve 331. As the striking force of the air stream upon the valve 331 varies, the reactive force of the compressed air against the valve also changes causing the valve to flap.

However, since the deflecting suction port has a vent at the bent portion of the guide 325, no reactive force against the valve 331 will develop and therefore the valve 331 will not vibrate.

Although in the foregoing, we have described the case in which the first fine filter 300 is provided in the dust case 200, the vacuum cleaner of this invention can be operated without the first fine filter 300. In this case, the coarse dust is collected in the inner space of the dust case 200 in front of the coarse filter 410 and

the fine dust is caught by the second fine filter 414. The coarse and fine dusts thus collected can be disposed of at one time by removing the filter unit 400 through the rear opening of the dust case 200.

Where the first fine filter 300 is employed, the coarse filter 412 does not function as a filter but rather as a member for supporting the first fine filter 300.

On the other hand, when the first fine filter 300 is not used, the coarse filter 412 works as a filter. The coarse filter 412 catches only coarse dust and let pass the fine dust which is arrested by the second fine fine filter 414.

The dust removing operation for the second fine filter 414 is performed in a manner already mentioned; and the coarse filter 410 is removed of dust by the vibration caused by the hammer rod 428.

CLAIMS

1. Vacuum cleaner comprising :

a body case (100) having a moter-driven fan (109):

a dust case (200) detachably connected to said body case (10_0):

a first fine filter member (300) detachably arranged in said dust case (200); and

a filter sustaining member (410) arranged in said dust case (200) for sustaining said fine filter member (300) in contact with the outer surface thereof.

2. A vacuum cleaner as claimed in claim 1, wherein further comprising a filter unit (400) arranged downstream of said first fine filter member (300) for catching dusts having passed through said first fine filter member (300).

3. A vacuum cleaner as claimed in claim 2, wherein further comprising a dust removing member (420,428) arranged in said dust case (200) for removing dusts caught on at least one of said first fine filter member (300) and said filter unit (400) therefrom.

4. A vacuum cleaner as claimed in claim 3, wherein said dust removing member (420,428) is driven by a cord winding device (111) arranged in said body case (100).

5. A vacuum cleaner as claimed in claim 1 or 3, wherein further comprising a vibrating device (428) arranged in said dust case (200) for vibrating said filter sustaining member (410).

6. A vacuum cleaner as claimed in claim 5, wherein said vibrating device (428) causes said filter sustaining member (410) seesaw movement so as to give shaking motion to said first fine filter member (300).

7. A vacuum cleaner as claimed in claim 1, wherein said dust case (?00) has a plurality of ribs (234) on the inner surface to sustain said first fine filter member (300).

8. A vacuum cleaner as claimed in claim 1, wherein said first fine filter member (300) comprises a bag (301) made of thin, flexible, porous paper and a support plate (303) made of hard paper.

9. A vacuum cleaner as claimed in claim 2, wherein said filter unit (400) comprises a coarse filter frame (402), a second fine filter frame (404), a filter support base plate (406) and a seal packing (408), the second fine filter frame having a re-use type of wave-shaped second fine filter (417) made of nonwoven fabric.

10. A vacuum cleaner as claimed in claim 1, wherein further comprising a dust case cover (220) detachably connected to said dust case (?00).

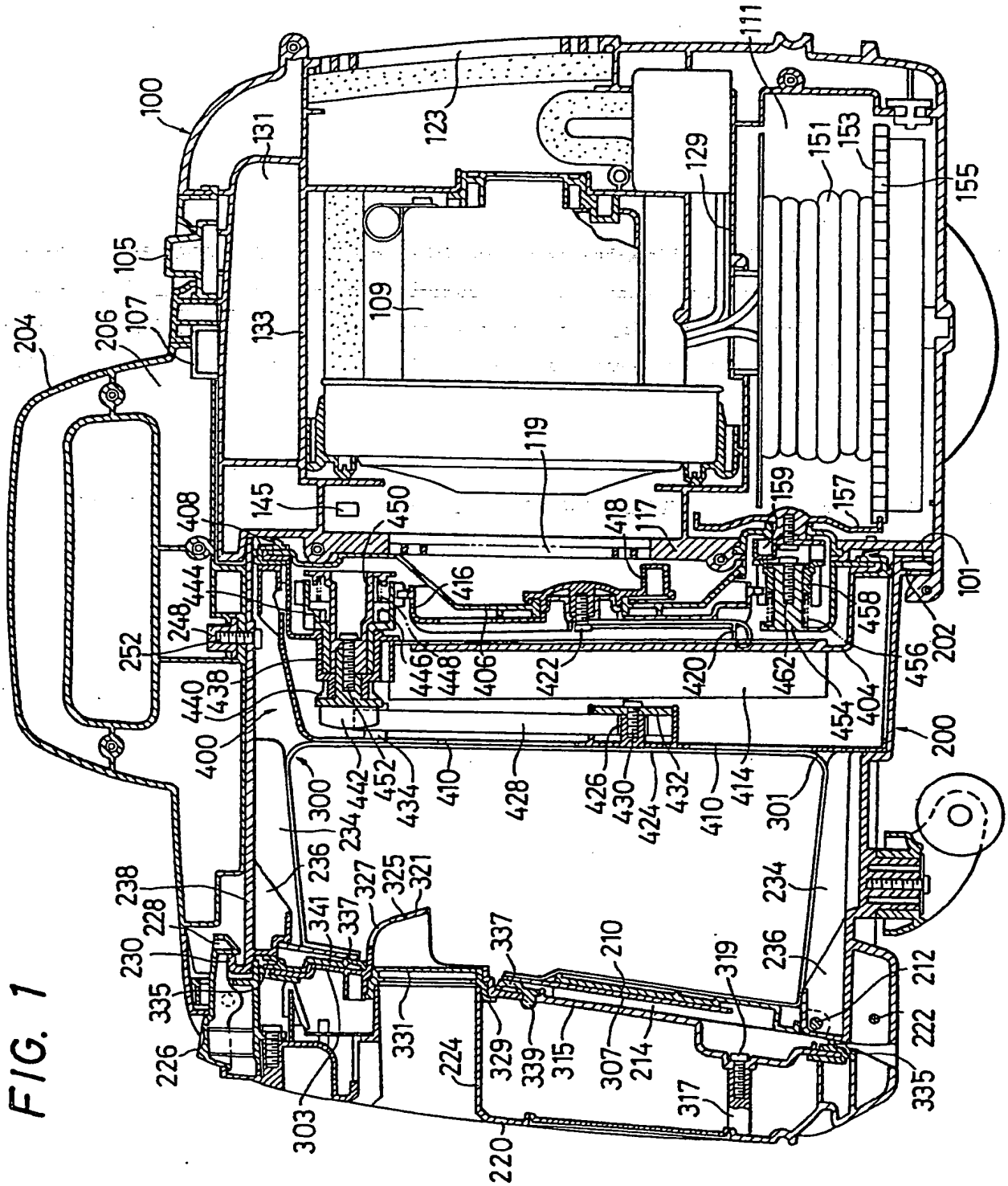

100
131
123
111
129
151
153
155
105
107
204
206
109
133
119
145
408
450
418
117
159
157
101
444
248
252
416
458
446
448
406
422
420
462
456
202
440
438
454
404
400
200
442
452
434
410
428
426
430
424
432
414
301
300
234
236
238
228
230
335
327
325
321
341
337
210
319
212
222
226
331
224
329
339
315
307
214
317
303
220

FIG. 1

FIG. 2

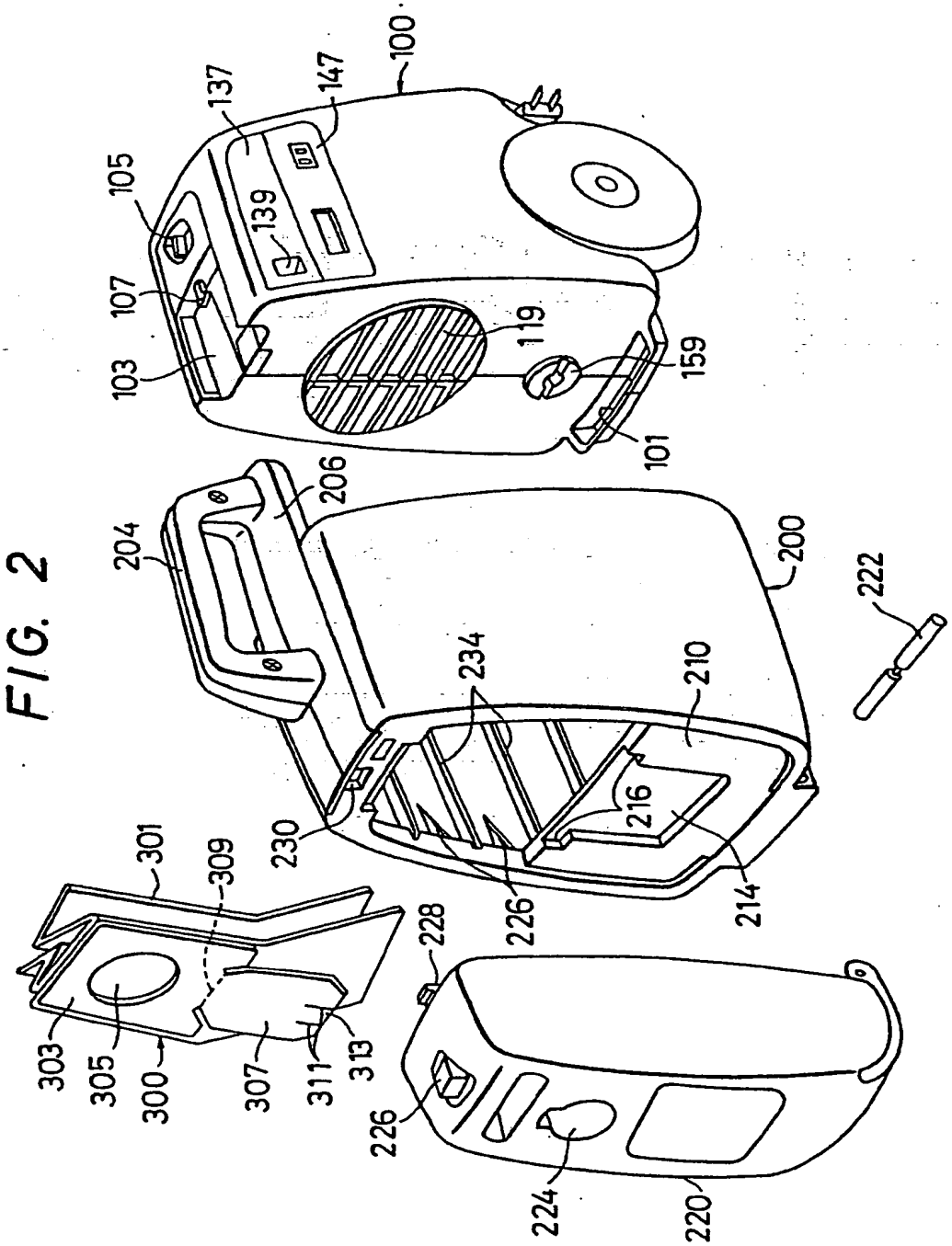

100
137
147
105
139
107
103
119
159
101
206
204
200
222
234
210
230
216
214
226
301
309
228
303
305
300
307
311
313
226
224
220

FIG. 3

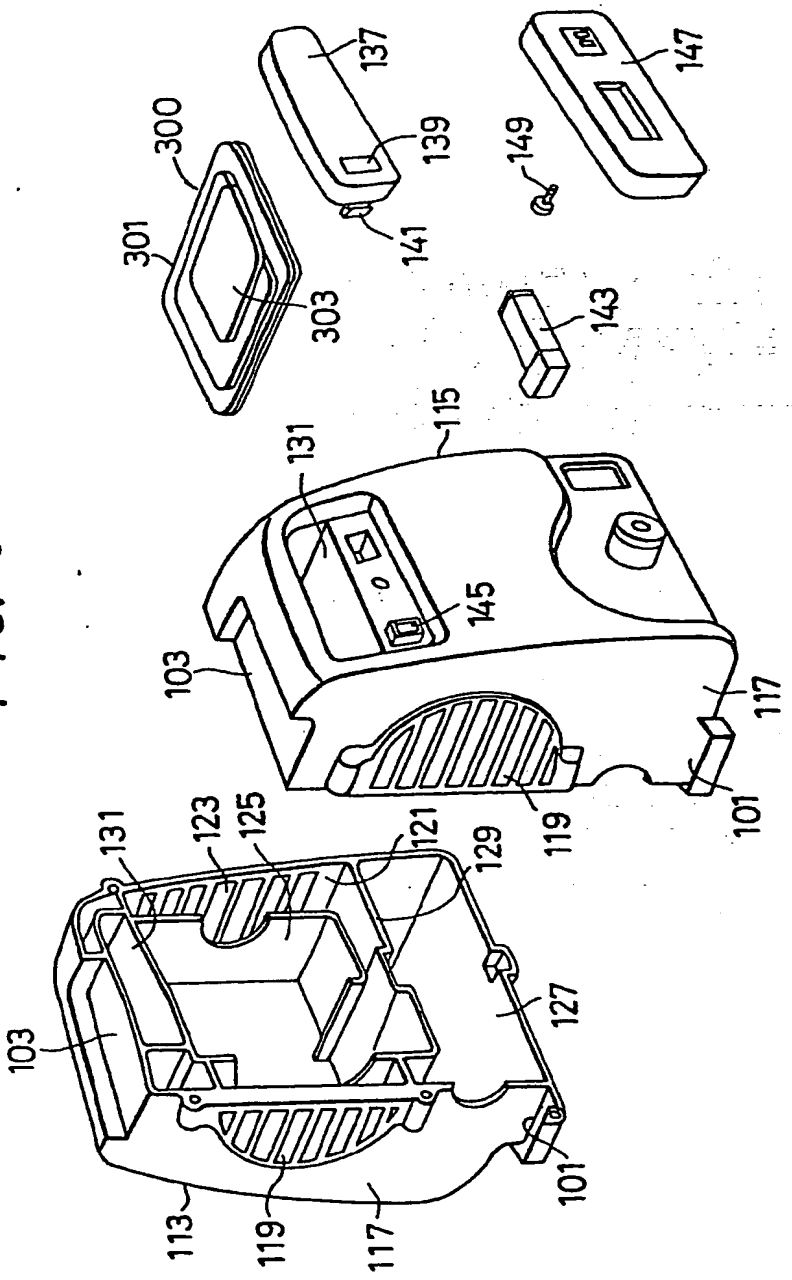

300
301
303
137
139
141
143
147
149
115
131
145
103
117
101
119
123
125
121
129
127
113

FIG. 4

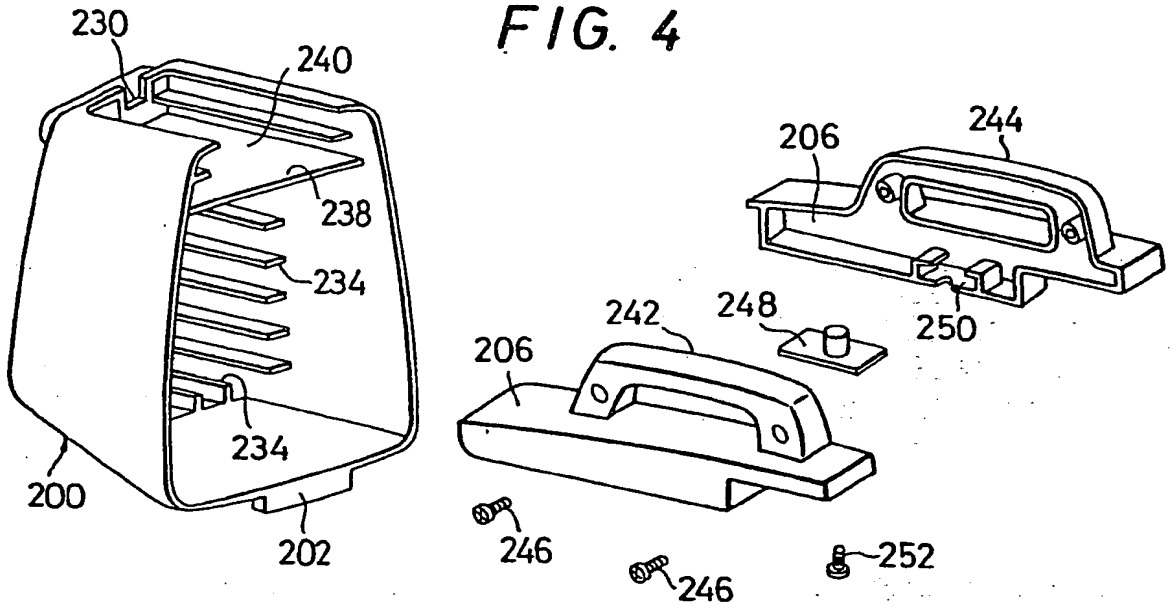
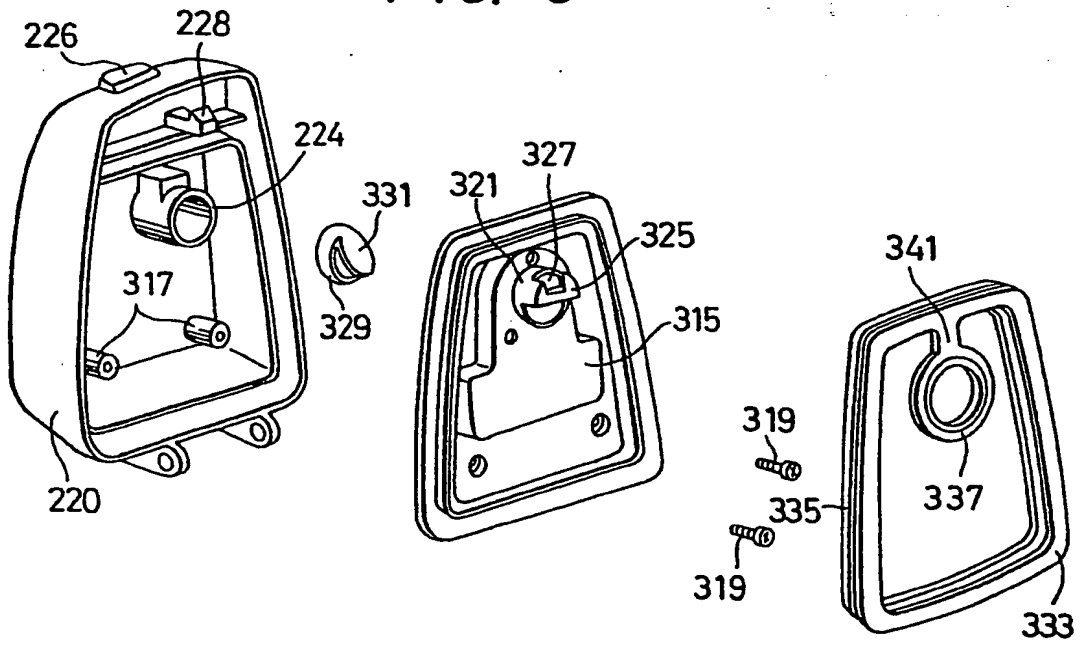

230
240
238
234
234
200
202
206
244
250
242
248
206
246
246
252

FIG. 5


226
228
224
331
317
329
220
321
327
325
315
341
319
335
319
337
333

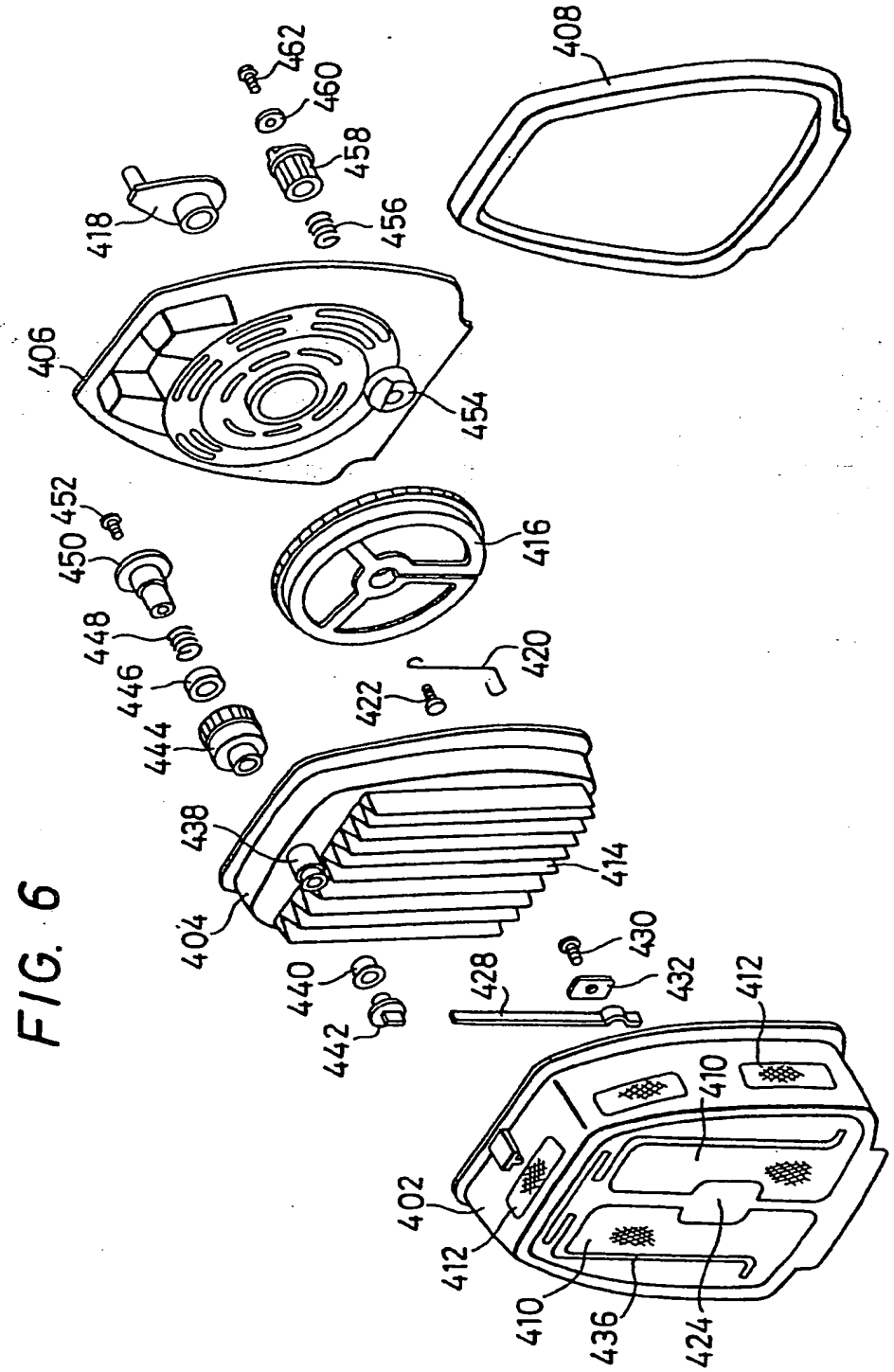

408
462
460
458
456
418
406
454
452
450
448
446
444
416
420
422
438
414
404
430
440
428
432
412
442
410
402
412
410
436
424

FIG. 6

FIG. 7

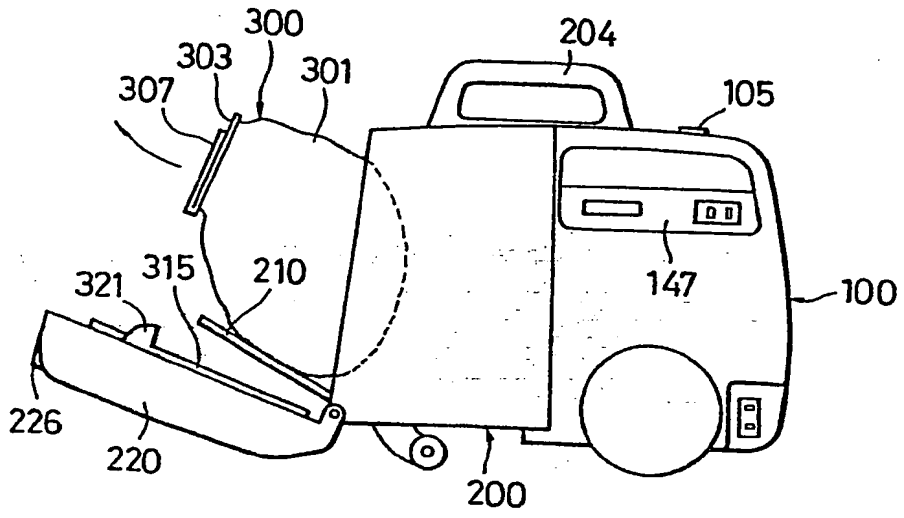

300
303
307
301
204
105
315
210
321
147
100
226
220
200

FIG. 8

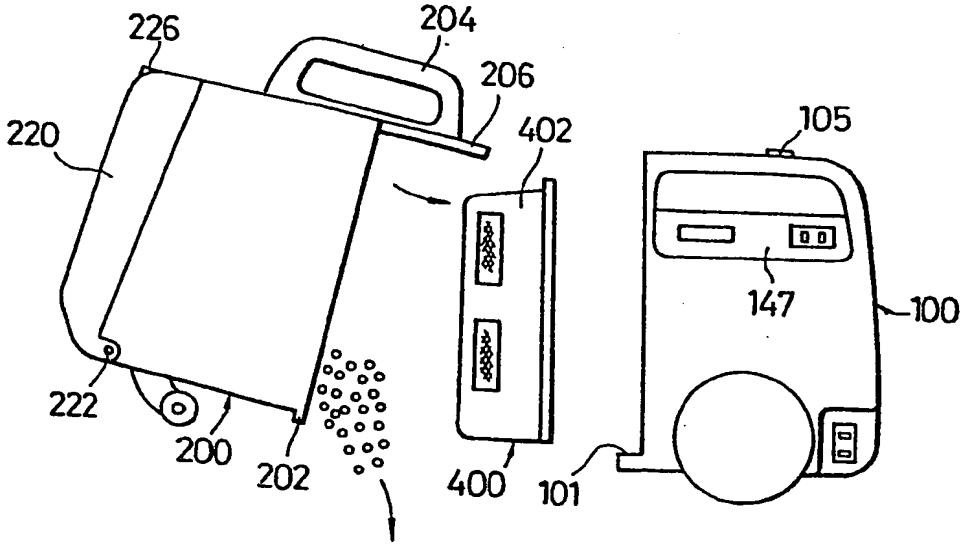

226
204
206
220
402
105
147
100
222
200
202
400
101

FIG. 9

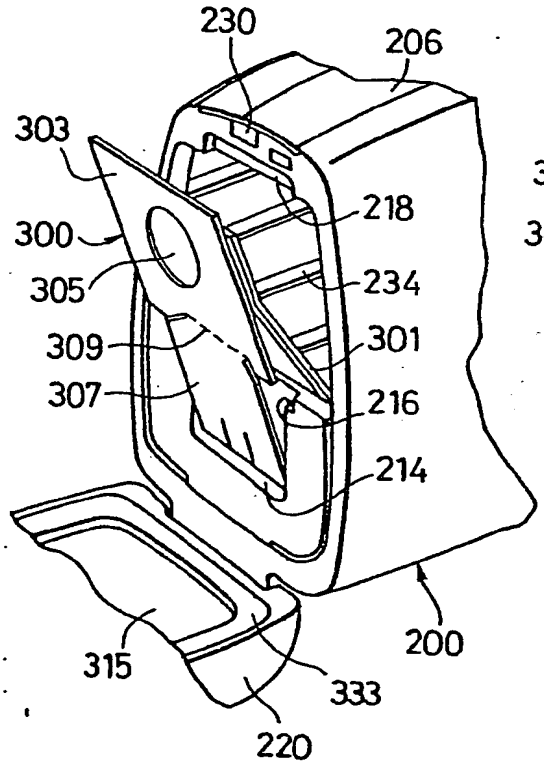


FIG. 10

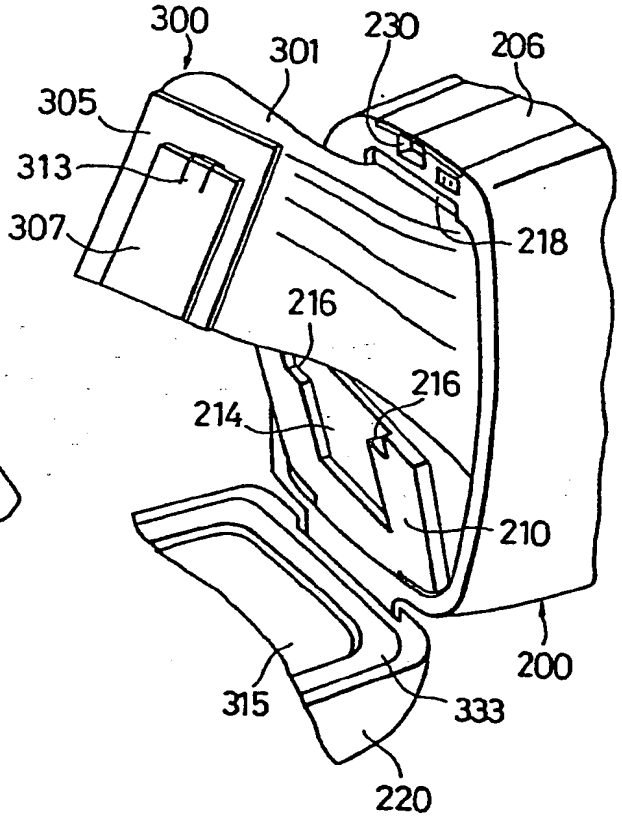


FIG. 11

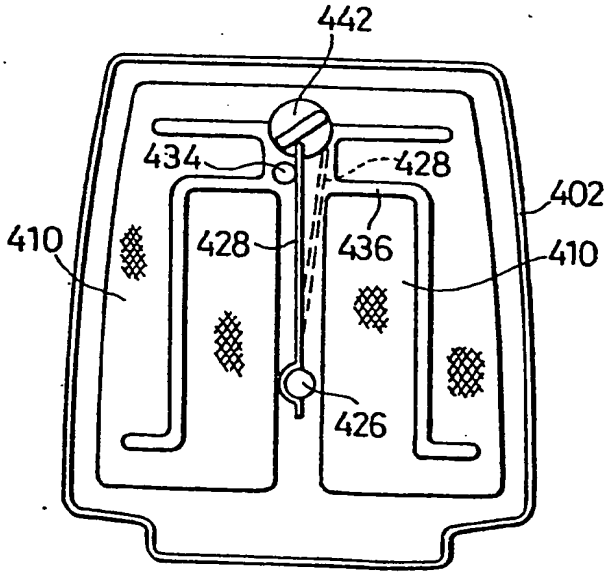


FIG. 12

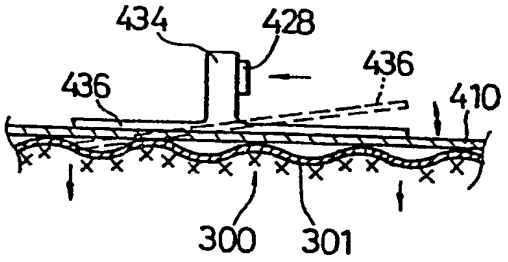


FIG. 13

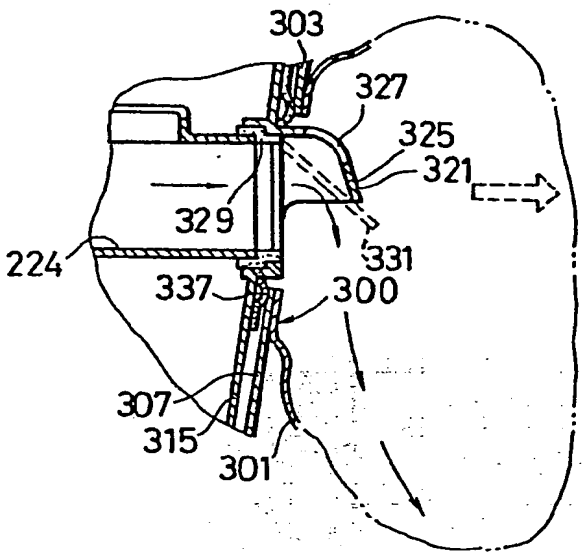


FIG. 14

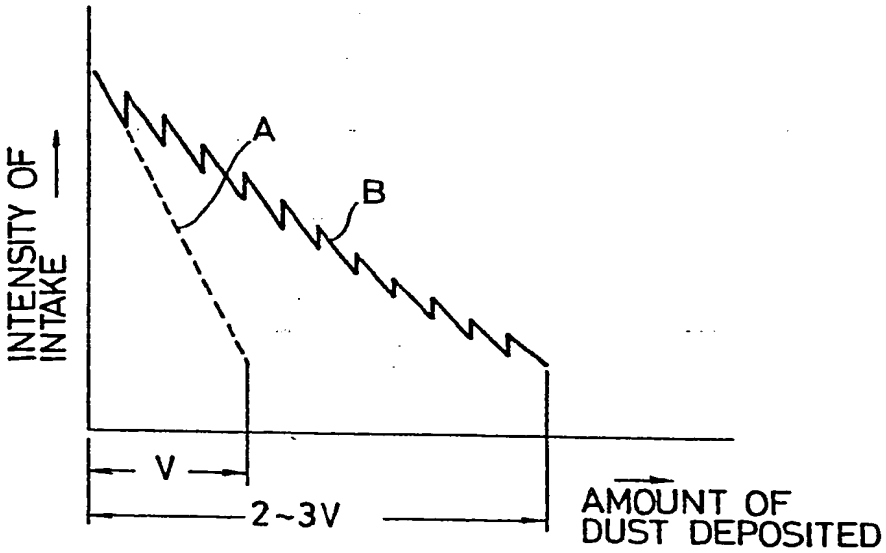
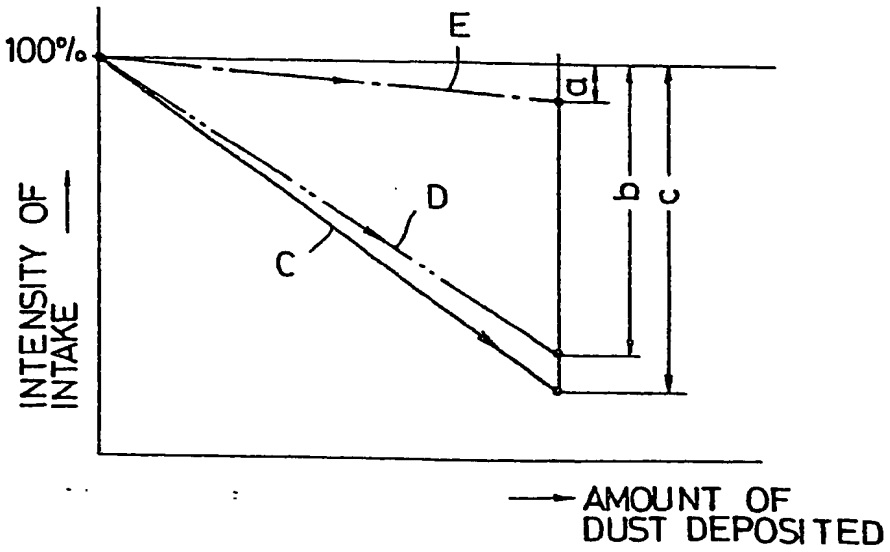


FIG. 15



0024636

Application number

EP 80 10 4787.9

European Patent Office

EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
	DE - A1 - 2 601 037 (HITACHI) * complete document * --	1,3,4	A 47 L 9/00
	DE - B - 1 951 306 (MATSUSHITA) * claim 1 * --	3	
	US - A - 1 991 859 (LOFGREN) * fig. 1 * --	1	TECHNICAL FIELDS SEARCHED (Int.Cl.³)
A	DE - U - 1 836 494 (FROBANA) ----		A 47 L 9/00

CATEGORY OF CITED DOCUMENTS

- X: particularly relevant
- A: technological background
- O: non-written disclosure
- P: intermediate document
- T: theory or principle underlying the invention
- E: conflicting application
- D: document cited in the application
- L: citation for other reasons
- &: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	20-11-1980	KLITSCH

EPO Form 1503.1 06.78

BEST AVAILABLE COPY